

**What is claimed is:**

1. A high-density plasma CVD process comprising the steps of:

a) preparing a semiconductor substrate;

b) loading the semiconductor substrate into a process chamber; and

5 c) injecting first main process gases including a silicon source gas, an oxygen gas, a nitrogen free chemical etching gas and a hydrogen gas into the process chamber to generate a high density plasma over the semiconductor substrate and to simultaneously form a silicon oxide layer on the semiconductor substrate, wherein the semiconductor substrate is heated to a temperature in a 10 range of about 550°C to about 700°C.

2. The high-density plasma CVD process according to claim 1,

wherein the high density plasma is generated by applying a plasma power to an induction coil installed outside the process chamber and a bias power to the 15 semiconductor substrate during the injection of the first main process gases.

3. The high-density plasma CVD process according to claim 2,

wherein the plasma power is in the range of about 2500 to about 5000 watts and the bias power is in the range of about 800 to about 4000 watts.

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4. The high-density plasma CVD process according to claim 1,

wherein the silicon source gas is a silane ( $\text{SiH}_4$ ) gas or a disilane ( $\text{Si}_2\text{H}_6$ ) gas, and the nitrogen free chemical etching gas is a silicon fluoride ( $\text{SiF}_4$ ) gas.

5. The high-density plasma CVD process according to claim 1,  
further comprising the step of injecting preliminary process gases into the  
process chamber prior to the injection of the first main process gases to generate  
5 a high density plasma over the semiconductor substrate and to simultaneously  
form an initial silicon oxide layer on the semiconductor substrate, wherein the  
preliminary process gases include a silicon source gas, an oxygen gas and a  
helium gas.

10 6. The high-density plasma CVD process according to claim 1,  
further comprising the step of injecting preliminary process gases into the  
process chamber after the injection of the first main process gases, wherein the  
preliminary process gases include a silicon source gas, an oxygen gas and a  
helium gas.

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7. The high-density plasma CVD process according to claim 1,  
further comprising the step of injecting second main process gases into the  
process chamber after the injection of the first main process gases, wherein the  
second main process gases include a silicon source gas, an oxygen gas, a  
20 nitrogen free chemical etching gas, a hydrogen gas and a helium gas.

8. The high-density plasma CVD process according to claim 7, further comprising the step of injecting preliminary process gases into the process chamber after the injection of the second main process gases, wherein the preliminary process gases include a silicon source gas, an oxygen gas and a helium gas.

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9. The high-density plasma CVD process according to claim 7, further comprising the step of injecting third main process gases into the process chamber after the injection of the second main process gases, wherein the third main process gases include a silicon source gas, an oxygen gas and a hydrogen gas.

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15 10. The high-density plasma CVD process according to claim 9, further comprising the step of injecting preliminary process gases into the process chamber after the injection of the third main process gases, wherein the preliminary process gases include a silicon source gas, an oxygen gas and a helium gas.

20 11. The high-density plasma CVD process according to claim 1, further comprising the step of injecting third main process gases into the process chamber after the injection of the first main process gases, wherein the third main process gases include a silicon source gas, an oxygen gas and a hydrogen gas.

12. The high-density plasma CVD process according to claim 11,  
further comprising the step of injecting preliminary process gases into the  
process chamber after the injection of the third main process gases, wherein the  
5 preliminary process gases include a silicon source gas, an oxygen gas and a  
helium gas.

13. A high-density plasma CVD process comprising the steps of:  
a) preparing a semiconductor substrate;  
10 b) loading the semiconductor substrate into a process chamber; and  
c) injecting first main process gases including a silicon source gas, an  
oxygen gas, a nitrogen free chemical etching gas, a helium gas and a hydrogen  
gas into the process chamber to generate a high density plasma above the  
semiconductor substrate and to simultaneously form a silicon oxide layer on the  
15 semiconductor substrate, wherein the semiconductor substrate is heated to a  
temperature in the range of about 550° to about 700°C.

14. The high-density plasma CVD process according to claim 13,  
wherein the high density plasma is generated by applying a plasma power to an  
20 induction coil installed outside the process chamber and a bias power and to the  
semiconductor substrate during the injection of the first main process gases.

15. The high-density plasma CVD process according to claim 14, wherein the plasma power is in a range of about 2500 to about 5000 watts and the bias power is in a range of about 800 to about 4000 watts.

5 16. The high-density plasma CVD process according to claim 13, wherein the silicon source gas is a silane ( $\text{SiH}_4$ ) gas or a disilane ( $\text{Si}_2\text{H}_6$ ) gas, and the nitrogen free chemical etching gas is a silicon fluoride ( $\text{SiF}_4$ ) gas.

10 17. The high-density plasma CVD process according to claim 13, further comprising the step of injecting preliminary process gases into the process chamber prior to the injection of the first main process gases to generate a high density plasma over the semiconductor substrate and to simultaneously form an initial silicon oxide layer on the semiconductor substrate, wherein the preliminary process gases include a silicon source gas, an oxygen gas and a 15 helium gas.

20 18. The high-density plasma CVD process according to claim 13, further comprising the step of injecting preliminary process gases into the process chamber after the injection of the first main process gases, wherein the preliminary process gases include a silicon source gas, an oxygen gas and a helium gas.

19. The high-density plasma CVD process according to claim 13,  
further comprising the step of injecting second main process gases into the  
process chamber after the injection of the first main process gases, wherein the  
second main process gases include a silicon source gas, an oxygen gas, a  
5 nitrogen free chemical etching gas and a hydrogen gas.

20. The high-density plasma CVD process according to claim 19,  
further comprising the step of injecting preliminary process gases into the  
process chamber after the injection of the second main process gases, wherein  
10 the preliminary process gases include a silicon source gas, an oxygen gas and a  
helium gas.

21. The high-density plasma CVD process according to claim 19,  
further comprising the step of injecting third main process gases into the process  
15 chamber after the injection of the second main process gases, wherein the third  
main process gases include a silicon source gas, an oxygen gas and a hydrogen  
gas.

22. The high-density plasma CVD process according to claim 21,  
20 further comprising the step of injecting preliminary process gases into the  
process chamber after the injection of the third main process gases, wherein the  
preliminary process gases include a silicon source gas, an oxygen gas and a  
helium gas.

23. The high-density plasma CVD process according to claim 13,  
further comprising the step of injecting third main process gases into the process  
chamber after the injection of the first main process gases, wherein the third  
5 main process gases include a silicon source gas, an oxygen gas and a hydrogen  
gas.

24. The high-density plasma CVD process according to claim 23,  
further comprising the step of injecting preliminary process gases into the  
10 process chamber after the injection of the third main process gases, wherein the  
preliminary process gases include a silicon source gas, an oxygen gas and a  
helium gas.